MARISCAL QUICKSILVER MINE
AND REDUCTION WORKS
(Lindsey Mine)
(Ellis Mine)
(The 34 Mine)
(Vivianna Mine)
Big Bend National Park
Mariscal Mountain
Brewster County
Texas

HAER No. TX-72

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PHOTOGRAPHS

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HISTORIC AMERICAN ENGINEERING RECORD

National Park Service
Washington, D.C. 20240

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MARISCAL QUICKSILVER MINE
& REDUCTION WORKS
(Lindsey Mine)
(Ellis Mine)
(The 34 Mine)
(Vivianna Mine)

HAER No. TX-72

Location:	Big Bend National Park, Brewster County, Texas
Date of Construction:	1916, 1919, 1942
Fabricators:	W. K. Ellis, William D. Burcham, Curt Scheutte
Present Owner:	National Park Service, Big Bend National Park
Present Use:	Closed (1944)
Significance:	Protected within the boundaries of Big Bend National Park, the abandoned mineworks of Mariscal Quicksilver Mine & Reduction Works are the best preserved complex of historic structures that illustrate the mercury mining industry in the United States.
Historian:	Arthur R. Gómez, August 1997

Project Information:

At the request of Big Bend National Park Superintendent José Cisneros, the National Park Service, Intermountain Cultural Resources Center, Santa Fe, New Mexico, joined the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER), Washington, D.C., in a cooperative effort to complete the historical and architectural documentation of this structure during the summer of 1997.

CHRONOLOGY

1900	Martín Solís discovers cinnabar on Mariscal Mountain
1903	Ed Lindsey files earliest mining claim on Mariscal
1906	Lindsey sells claims to Texas Almaden Mining Company

1909	Texas Almaden Company relinquishes all of its claims
1916	W. K. Ellis purchases all mineral rights to Mariscal
1917	Ellis Mine (The 34 Mine) and retort furnaces in full production
1919	Ellis sells his interests to William D. Burcham, Burcham constructs Scott furnace and condenser system
1923	Mariscal Mining Company closed because of financial indebtedness
1936	Court awards A. C. Spalding all rights to Mariscal mining properties
1942	Burcham reorganizes financially and establishes the Vivianna Mining Company
1944	Vivianna Mining Company declared insolvent and closed, with the establishment of Big Bend National Park, ownership transfers to the National Park Service
1948	Robert N. Pulliam removes equipment for salvage

INTRODUCTION

During the summer of 1997, the Historic American Engineering Record, in conjunction with the history staff of the Intermountain Cultural Resource Center, conducted a three month historical and architectural study of the mercury mining industry in Big Bend National Park, Brewster County, Texas, about 40 miles southwest of Terlingua.

Second only to California as the nation's leading producer of mercury--and for a brief one-year period (1921) its largest producer--the volcanic landscape of west Texas was once pock-marked with mining activity. Corporate owned as well as two-man operations riddled the mountain sides near familiar topographic landmarks such as Terlingua Creek, Study Butte, Fresno-Contrabando Dome, Maravillas Creek and Mariscal Mountain. In all, more than thirty mines comprised the Terlingua District, a narrow belt extending for approximately fifteen miles east to west. Their combined total accounted for 90 percent of the more than 150,000 flasks (76 pounds per flask) of mercury produced in the district from 1899 to 1970. Although productivity at Mariscal Mine, located forty miles southeast of Terlingua, paled in comparison to that of its principal competitors--the Chisos Mining Company of Terlingua and the Big Bend Cinnabar Mining Company at Study Butte--the citadel-like edifice, perched high atop the eastern face of Mariscal Mountain, stands as a final testament to the halcyon days of this once vibrant Texas industry.[1]

Although a known element since the days of the Mesopotamian Empire (ca. 2000 B.C.), mercury enjoyed widespread use throughout Europe and Asia as an amalgam for processing gold and silver beginning about 400 B.C.. The advance of European monarchies to the New World in the fifteenth and sixteenth centuries initiated the quest to discover new sources of mercury comparable to the ores extracted from Spain's famous Alamaden Mine, which first produced the metal as early as the twelfth century from crude shaft furnaces. By 1646 more efficient methods of reduction were developed at the Huancavelica Mine in Peru, thus enabling Spain to dominate the mercury production industry well into the present century.

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[1]Roger D. Sharpe, Development of the Mercury Mining Industry: Trans-Pecos Texas, Mineral Resource Circular No. 64 (Austin: Bureau of Economic Geology, 1980), 13; J. Harlan Johnson, "A History of Mercury Mining in the Terlingua District of Texas," Part I, The Mines Magazine (September 1946), 190-91; Clifford B. Casey, Soldiers, Ranchers and Miners in the Big Bend (Santa Fe: Department of the Interior, National Park Service, Southwest Regional Office, 1969), 211-13.

Not until 1845, however, when Captain Andrés Castillero, a young Mexican cavalry officer and an experienced metallurgist, located a cave twelve miles south of present San José, California, was the occurrence of mercury on the North American continent confirmed. Castillero's discovery and the subsequent establishment of the New Almaden Mine on the eve of the great California gold rush was nothing short of providential. These two historic events combined to initiate the mercury mining industry in the United States. During the decades 1890 to 1940, America ranked second only to Spain as the world's leading producer of "quicksilver"--the commercial name for mercury.

Among its many uses, the industrial, medical, and military applications of mercury have accounted for 87 percent of U.S. consumption since the birth of the industry. Mercury is unique as the only metal in liquid form at ordinary temperatures. It has seen use in the manufacture of chlorine and caustic soda, also in electrical components including lighting equipment and batteries, as well as precision measurement instruments such as thermometers and barometers. In more recent applications, mercury saw widespread use as a binding agent in the production of pulp and paper, as a mildew retardant for paints, and as an amalgam for dental preparations.

It is mercury's well known explosive qualities, however, that has accounted for the uneven market fluctuations coincident with U.S. involvement in global warfare. During such periods, the metal, once converted into a crystalline fulminate, becomes the principal chemical ingredient in the manufacture of detonators as well as other munitions. While there are few satisfactory substitutes for mercury in the production of electrical apparatus and control instruments, sulpha drugs, iodine and other antiseptics have replaced this unique metal in pharmaceutical use. Similarly, porcelain and plastics have become the preferred material employed in dentistry. Production statistics for Mariscal Mine indicate, however, that it was mercury's strategic uses that provided the largest market for the ores it produced.[2]

BACKGROUND

The mercury mining industry in west Texas had it origin in Terlingua. While on a mapping expedition through the Trans-Pecos

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[2] D. M. Lindell, The Handbook of Non-Ferrous Metallurgy 2 vols.(New York and London 1945), 1,227; Carey McWilliams, North from Mexico: The Spanish-Speaking People of the United States (1949; reprint, New York: Greenwood Press, 1968) 139-40; Sharpe, Mercury Mining Industry, 11; "Mercury Potential of the United States," Bureau of Mines Information Circular 8252 (Washington: Department of the Interior, Bureau of Mines, 1965), 338.

region with the Army Corps of Topographical Engineers in 1840, German geologist Dr. Ferdinand Von Roemer noted numerous sporadic outcroppings of cinnabar, the reddish rock from which mercury is derived. More than a half-century elapsed, however, before west Texans produced the metal in earnest. Generally speaking, mercury ore in the Trans-Pecos region was mined by conventional surface and subsurface methods. Early exploratory methods consisted of sinking shallow shafts or trenches on the surface exposures of cinnabar and then using a diamond-bit, mechanically driven drill to determine the extent of the subsurface deposits. Deeper ore deposits were mined by traditional subsurface methods including drifting, in which workings were driven laterally along mineralized zones; and stoping, in which mineralized zones were mined from the bottom upward. Horizontal passageways or crosscuts connected the drifts and stopes, while the ore was extracted from the mine by a series of inclined or horizontal adits (tunnels). According to one early inspection report by geologist Curt N. Schuette: "The mining methods employed during these early years were indeed primitive with picks, shovels, hand drills, and sledge hammers making up the standard compliment of equipment. As diggings descended to subsurface levels, Mexican laborers surfaced the ore-bearing material in rawhide buckets weighing in excess of eighty pounds attached to their backs."[3]

In 1896 two brothers, Bert and James Normand, owners of the Marfa and Mariposa Mining Company, were the district's first successful commercial producers. Their holdings were in the western sector of the Terlingua District, where they produced upwards of 30,000 flasks of mercury during little more than a decade of operation. By 1905 the mining district had expanded eastward with the establishment of the Texas Almaden Mining Company, known locally as the Dallas Mining Company, and the Big Bend Cinnabar Mining Company near the present day village of Study Butte. It was not until the arrival of Chicagoan Howard E. Perry to west Texas, however, that the transformation of the Terlingua District from that of a regional producer of mercury to one with a worldwide reputation began to take shape.[4]

Howard Everett Perry, a wealthy industrialist who had earned his

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[3]Casey, Soldiers, Ranchers and Miners, 209-11, 215-19; Sharpe, Mercury Mining Industry, 9-13; Arthur R. Gómez, A Most Singular Country: A History of Occupation in the Big Bend (Provo: Brigham Young University, Charles Redd Center for Western Studies, 1994, 2d printing), especially 113-29; C. N. Schuette, Quicksilver, Bureau of Mines Bulletin Number 335, 3-7.

[4]Johnson, "Mercury Mining in the Terlingua District," Part I, 392-94; Kenneth Baxter Ragsdale, Quicksilver: Terlingua & the Chisos Mining Company (College Station: Texas A & M University Press, 1995, 3d printing), 16-18.

fortune as a shoe manufacturer, inherited a small parcel of land in Brewster County in compensation for an unpaid debt. Not one to let a business opportunity go unheeded, Perry filed a lawsuit that won him uncontested ownership of the mining claim near Terlingua. Next, he purchased several adjoining parcels of land and secured a loan of $50,000 to capitalize the Chisos Mining Company, which he incorporated in May 1903. In its first year of production, the Chisos Mine employed four 700-pound D-type retort furnaces to produce 5,029 flasks of mercury valued at $200,000. Significantly, this amount represented about one half of the total state output for that year. With the exhaustion of high-grade ores and the more frequent occurrence of ores containing less than 4 percent mercury, Perry, in 1905, purchased a 20-ton Scott furnace from the defunct Colquitt-Tigner Mine, five miles west of Terlingua. This improvement enabled his company to increase its conversion of cinnabar ore to quicksilver at the rate of fifteen tons every twenty-four hours. Nicknamed "El Perrito" by his Mexican employees because of his bulldog-like demeanor and ruthless nature, Perry pressured most of his early competitors out of business. In 1910, for example, the Normand brothers relinquished all of the Marfa and Mariposa Mine's claims to the Chisos Mining Company.

By far the largest workings in the Terlingua District, the Chisos Mine consisted of nearly twenty-three miles of subsurface diggings that extended 5,500 feet laterally and 840 feet vertically. During its peak production years (1905 to 1930), the Chisos Mining Company generally exceeded Howard Perry's personally imposed quota of 700 flasks per year. In fact, its level of productivity earned the Chisos Mining Company an impressive $30,000 per month during the period 1917 to 1930. In continuous operation from 1903 to 1942, this mine alone produced approximately two-thirds--100,000 flasks--of the total output for all of west Texas.[5]

Meanwhile, less than ten miles east of Terlingua, two additional mining companies rivaled for preeminence in the district. In 1905 W. L. Study opened the Big Bend Cinnabar Mining Company, while H. M. Nesmith sank a 150-foot shaft to begin the Texas Almaden Mining Company (Dallas Mining Company). The two Study Butte mines marked the easternmost boundary of the Terlingua District. During their first full year of production, the two operations combined accounted for 4,273 flasks of mercury. Their most productive years, however, appear to have coincided with World War I (1914-1918), during which time they accounted for

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[5]Ragsdale, Quicksilver, 22-79; Gómez, A Most Singular Country, 122-23. Statistics on Chisos Mine as cited in Sharpe, Mercury Mining Industry, 13.

more than $500,000 worth of mercury. Notably, in 1915, management of the Big Bend Cinnabar Mining Company passed to William D. (Billy) Burcham, who renamed it the Study Butte Mining Company and resumed production in January 1916. Burcham wasted no time in designing and installing a "model" 50-ton Scott furnace to increase the productivity of the resuscitated operation. A California-trained engineer with four years practical experience in west Texas, Burcham would, in just a few short years, apply his technical "know how" at Mariscal Mine.[6]

As the mines of the Terlingua District expanded in number and increased in productivity, other mercury-bearing deposits were being recovered forty miles to the southeast near Mariscal Mountain. While local cattle rancher Martín Solís detected evidence of cinnabar along the northern ridge of the mountain in 1900, no mining appears to have taken place before U.S. Immigration Inspector D. E. (Ed) Lindsey filed numerous claims in what he believed to be Section 34, Block G-3 of Brewster County. A government employee with a flare for entrepreneurism, Lindsey established a small general mercantile near his U.S. Customs headquarters (present Barker House near the Boquillas Canyon overlook) soon after his arrival to Big Bend in 1894 to supply American and Mexican miners. Cognizant of the commercial potential of the Solís discovery, Lindsey filed his claims in 1903 and immediately began mining the high-grade surface ores, which he loaded onto burros for transport to the Study Butte and Terlingua mines for reduction.[7]

Not long thereafter, Issac Sanger of Dallas, one of several part owners of the Texas Almaden Mining Company, challenged the so-called Lindsey Mine's claims to Mariscal Mountain in Brewster County court. Sanger and his partners accused Ed Lindsey of developing lands in Section 33 and not Section 34, where Lindsey was said to have filed. The court, therefore, ordered an official survey of the contested area to determine the exact boundary between lands that the Lindsey Mine had filed upon against those claimed by the Texas company. The survey found in favor of the Dallas-based corporation, and in November 1905 transferred all mineral rights in Section 33 to Sanger's Texas Almaden Mining Company. The following year, Ed Lindsey sold all of his claims to the Texas Alamaden Mining Company and returned

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[6]Johnson, "Mercury Mining in the Terlingua District," Part I, 392-94; Sharpe, Mercury Mining Industry, 20, Alpine Avalanche, June 8, 1972.

[7]Clyde P. Ross, "Quicksilver in the Terlingua Region, Texas," Economic Geology, 36 (n.d.), 119; Gómez, A Most Singular Country, 116, 126; Brewster County Mining Records, vol. 1, 527-38; Brewster County Deed Records, vol. 9, 119.

full-time to his business activities in Boquillas. It has been estimated that the amount of ore Lindsey shipped to Terlingua produced only a paltry 50 flasks of mercury during his brief occupancy on Mariscal Mountain. Nevertheless, Lindsey reportedly earned $35,000 from the sale of his five patented claims.

Issac Sanger's acquisition of Section 34 was indeed significant. While Section 33, which adjoins the former on the west side of Mariscal Mountain, contained most of the mining claims of any real value, Section 34 presented a somewhat flatter topography, better suited to the construction of a reduction facility with all of its appurtenant buildings. Under the direction of H. M. Nesmith, the same superintendent of the Texas Alamaden Mining Company facility in Study Butte, the company carried out extensive exploration on Section 33, as it drafted plans to construct a furnace for treating the ores that appeared to be in sufficient quantity to assure the proposed mine commercial success. However, a sudden, dramatic drop in the market price of quicksilver forced the Dallas firm to table its plans for the development of Mariscal, and instead to focus on its Study Butte operation, where a furnace was already successfully in place. In response, the Texas Almaden Mining Company dropped its leases on Mariscal Mountain in 1909, and the area remained virtually unattended until the advent of the First World War.[8]

President Woodrow Wilson's decision to declare war on Germany in April 1917 and the subsequent commitment of American troops to France, prompted an unprecedented demand for quicksilver--especially mercury fulminate--on a global scale. According to writer/historian Kenneth Ragsdale, "Used as a primer to detonate gunpowder in cartridges and shells, mercury became a critical material in war . . . and its economic potential multiplied manyfold." Indeed, mercury production in west Texas alone doubled from an annual average output of 3-4,000 flasks from 1910 to 1915 to an average 8,000 flasks per year from 1915-1919, the highest production level being 10,791 flasks in 1917. Inasmuch as the War Department, the sole purchaser of the strategic metal during those years, paid as high as $125 per flask, the industry flourished as never before or since.[9]

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[8]Brewster County Deed Records, Vol. 35, 546; Casey, Soldiers, Ranchers & Miners 224-26. Ross Maxwell, "The Mariscal Mine," in Paul H. Pausé and R. Gay Spears, eds, Geology of the Big Bend Area and Solitario Dome, Texas (Austin: West Texas Geological Society, 1986), 274.

[9]Quote as cited in Ragsdale, Quicksilver, 14; Production statistics as cited in J. Harlan Johnson, " A History of Mercury Mining in the Terlingua District of Texas," Part II, The Mines Magazine (October 1946), 447.

As the mines of the Terlingua District reaped enormous profits, speculators renewed interest in the idle workings on Mariscal Mountain. In February 1916 W. K. Ellis, a Midwestern businessman who first came to Big Bend to establish a wax production plant at Glenn Springs, a few miles northeast of Mariscal Mountain, purchased all of the mineral rights previously held by the Texas Almaden Mining Company. In addition to his purchase of Sections 33 and 34 on the northern extreme of Mariscal Mountain, Ellis wisely purchased Section 20 near Fresno Creek, a small perennial drainage that supplied all of the crucial water needs for the mining operation as well as daily consumption by its workers. Although Ellis began his operation--known variously as the Ellis Mine or the 34 Mine--by simply reworking the high-grade surfaces that Lindsey had previously recovered, he eventually sank a shallow shaft along the east face and northernmost end of the mountain. An excerpt from the 1917 U.S. Mineral Yearbook indicated that by June of that year, the Ellis Mine was working a 50-60 foot shaft. This subsurface penetration eventually became the main shaft not only for the Ellis Mine but also for all mining operations that followed.

While it is not known for certain if W. K. Ellis himself designed the processing facilities that accompanied his mining operation, it is known that he authorized the construction of three D-type retorts through which the high-grade cinnabar ore was processed (see Drawings Sheet 8). The same entry in the Mineral Yearbook described the ore-processing apparatus as follows:

> Three retorts in which the ore was treated in 1917 are of unusual design, consisting of specially cast tubes 16" in diameter and 12' long set at an angle of 45 degrees. They are charged at the top. The two end ones every 8 hours and the middle one every 6 hours, and discharge at the bottom. About half of the contents are removed before each charging and the total capacity of the 3 retorts is about 4 tons in 24 hours, with a consumption of 1-1/2 cords of wood. A manifold collects the quicksilver vapor and conducts it into small vitrified pipe condensers.

The entry noted further that while these retorts proved to be convenient to charge and discharge and appeared to function satisfactorily, there was an overall loss of quicksilver during processing. Larger retorts, therefore, were planned for installation in 1918 as high-grade ores became exhausted.[10]

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[10]Gómez, A Most Singular Country, 126-27; Casey, 226-28; Excerpts from Minerals Yearbook, 1917 as cited in William D. Burcham, "Geological Report: On the Vivianna Mine, Sections 33 and 34, Block G-5, Brewster County, Texas,

Of all the metals, quicksilver is probably the most easily recovered from its ore--cinnabar or mercuric sulfide. It can be easily reduced and, as it can be volatilized at a comparatively low temperature, thus separated without difficulty from nearly all substances that might be present in the ore. The principle upon which the extraction of mercury is based is a simple roasting operation that oxidizes the sulfide and produces mercury vapor. According to Curt N. Schuette, coauthor of The Metallurgy of Quicksilver, acclaimed as the definitive essay on the mining and processing of mercury, the melting point of cinnabar lies somewhere above 580 degrees centigrade, known as its subliming point. If sublimation alone is to be depended upon to extract the mercuric sulphide content of ore, temperatures somewhat above that melting point is required. When cinnabar is roasted with very little or no air, as when the ore or concentrate is retorted, chemical changes other than those involving oxidation of the sulphide are depended upon to separate the mercury.

In the complete absence of oxygen, very little mercury will be released until reaching the subliming point of the cinnabar ore; therefore, in the retort process, it was standard practice to release mercury from its combination with sulphur by adding lime to the charge.[11]

The retort furnace, such as those employed at the Ellis Mine, was the earliest device used for the extraction of quicksilver from the ore. Generally, the retort furnace served two purposes: 1] it was used in the treatment of selected ore and 2] the recovery of quicksilver from the intermediate products of the reduction works--i.e. mercurial soot. Quicksilver retorts (see Drawing Sheet 8) are generally made of cast iron, having either a circular or D-shaped cross section. They may be mounted singly or linked together in a furnace so arranged that the vaporous gases from the fire box will circulate around all sides of the retort. It is common to encase the retort in fire brick--or as in the case of the Ellis Mine retorts flagstone--so that the flames from the fire box will not impinge directly upon the cast

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1946" Exhibit B, 4 in W. D. Burcham Collection, Archives of the Big Bend, Special Collections Library, Sul Ross State University, Alpine, Texas, Box 2; Reference to "The 34 Mine" in Walter Harvey Weed, ed, The Mines Handbook: A Manual of the Mining Industry of the World, vol. 14 (New York: W.H. Weed, 1920), 1338.

[11]Most of the technical and processing information in this report is derived directly from L. H. Duschak and C. N. Schuette, Metallurgy of Quicksilver, Bulletin 222 (Department of the Interior, United States Bureau of Mines, 1925), 4, 7-11.

iron. Retorts are supported throughout their entire length by fire-clay tile. Two stacks are provided so that by means of the dampers the heat of each retort can be closely controlled.

As mentioned earlier, each of the three D-type retorts at the Ellis Mine had a capacity from 750 to 1,000 pounds per 24-hour period. Typically, the retort charge was placed in shallow iron pans, of which there are two for each retort, and charged every 8-12 hours. Upon completion of his inspection of the early workings in the Terlingua and Mariscal Districts, Schutte had this to say about the cost efficiency of the retort reduction method vìs a vìs smaller mining operations: "A small furnace is all that is needed to make a finished product that has a ready cash market."[12]

Although the reduction process itself was simple, it was labor intensive, thus requiring each mining operation to hire cheap labor in substantial numbers. Traditionally, W. K. Ellis had employed Mexican laborers at his Glenn Springs wax factory because of their special knowledge and experience in reducing the candelilla plant to a wax-like resin. Not unlike his competitors in the Terlingua District, Ellis, too, relied almost exclusively upon cheap skilled and unskilled Mexican labor to keep his quicksilver mine operational. Typically, experienced Mexican miners, many of whom had learned their trade in the Sierra Mojada silver district in southwestern Coahuila, earned $1.25 a day for a ten-hour, six-day work week. Unskilled miners and common laborers were paid a meager $0.90 a day for their efforts.

Most workers took up residence on the broad plain just below the mine works and not too distant from Fresno Creek, where they built make-shift hovels of creosote brush or Boquillas flagstone shaded by an ocotillo cactus roof into the mountain side (see Drawings Sheet 4). Mexican miners dug wells along the banks of Fresno Creek, making it the chief water source for the entire mining community. There is evidence on site, however, to suggest that the residents of Mariscal Mountain also dug holding ponds in an effort to capture what limited rainfall they could for community consumption.

Mexicans who did not find employment at the Ellis Mine no doubt

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[12]Ibid., 142-45; for other detailed information on retort furnaces see, Lewis E. Aubury, Quicksilver Resources of California, Bulletin 27, (Sacramento: California State Mining Bureau, 1908), 200-08; Walter W. Bradley, Quicksilver Resources of California, Bulletin 71 (Sacramento: California State Mining Bureau, 1918), 210-17; Burcham, "Geological Report on the Vivianna Mine," Exhibit B, 4; Schutte quote as cited in, Quicksilver, Bureau of Mines Bulletin Number 335, 3.

made a decent living providing needed services to the mining operation. Among the most critical of these services was wood hauling. In the absence of abundant fuel sources near the Ellis Mine, Mexican wood haulers used burros to pack huge quantities of mesquite either from the nearby village of San Vicente across the Rio Grande or more likely from the Chisos Mountains several miles to the northwest. During a 24-hour period, each retort at the Ellis Mine consumed one-half to three-quarters cord of wood. For this reason, Mexican wood haulers fared comparatively well inasmuch as good fuel wood sold anywhere from $5.00 to $7.00 per cord.

While only a short lived enterprise, the Ellis Mine proved to be the most successful producer of mercury among the three major operations that recovered cinnabar ore on Mariscal Mountain. Historical accounts indicate that the Ellis Mine, active from July 1917 to May 1919, produced and shipped 894 flasks of refined quicksilver, most of which was derived from high grade ore. At its peak, mercury sold for $125 per flask in 1916 dropping to about $117 per flask the following year, $105 in 1918, and eventually to $90 per flask in the final year of the Ellis Mine operation. Perhaps intuitively, W. K. Ellis quit the mining business and sold out his interest to Billy Burcham, former superintendent of the Study Butte Mine, on the eve of a major market recession for commercial quicksilver.[13]

Nevertheless, Burcham set out to develop his newly christened Mariscal Mine with all of the enthusiasm of an undaunted prospector in search of the mother lode. A graduate in 1910 from Stanford University's highly touted mining engineering program, Burcham supervised silver mining operations in Silver Peak, Nevada, and Shafter, Texas, before accepting the superintendency at Study Butte in 1915. On April 24, 1919, Burcham acquired the holdings of W. K. Ellis, including the latter's home at Glenn Springs, where Burcham and his wife, the former Rubye Richardson of Alpine, established headquarters for the recently incorporated Mariscal Mining Company. In partnership with Charles Bondies, August A. Wesserschied, and Baldwin F. Schirmer, three mining speculators from New York, Burcham capitalized his new company at

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[13]For additional information on the Ellis wax production plant at Glenn Springs, which W. D. Burcham purchased from Ellis in 1919 along with the mining operation at Mariscal Mountain see, Curtis Tunnell, Wax, Men, and Money: A Historical and Archeological Study of Candelilla Wax Camps along the Rio Grande Border of Texas, Report 32, (Austin: Texas Historical Commission, Office of the State Archeologist, 1981), 6-10; Casey, Soldiers, Ranchers and Miners, 228, 244-49; Production statistics for these years as cited in Johnson, "Mercury Mining in the Terlingua District," Part I, 393-94, Part II, 447.

$40,000 and promptly designated himself general manager. It was Burcham's intent to use most of the new capital to modernize Mariscal Mine.

To begin, Burcham extended the shaft that Ellis sank in 1917 to the 250-foot level in hope of penetrating the Buda Limestone formation, where mercury-bearing cinnabar commonly occurs in huge deposits (see Drawings Sheet 5). Notably, during the four years (1919-23) that Mariscal Mine operated, drifting did not extend to the 150-foot level. A more important renovation, however, was Burcham's decision to upgrade the mine's ore reduction system. In consort with Curt N. Schuette, a 1917 graduate of the College of Mining, University of California at Berkeley, and foreman at the mine since its inception, Burcham designed and built a four-tile, four-shaft, 50-ton capacity Scott furnace on the north slope of Mariscal Mountain (see Drawings Sheet 7) directly overlooking the old retort furnace system employed by the Ellis Mine. The new furnace--built at the cost of more than $10,000--contained 160,000 locally manufactured brick for its exterior. In addition, more than 20,000 fire brick were transshipped by rail from St. Louis to Marathon, Texas, then by freight wagon to the mine site to line the interior of the three-story structure. A description of the furnace, which appeared in a 1929 San Francisco publication, noted one characteristic of the Scott furnace at Mariscal Mine that distinguished it from those common to the Terlingua District:

> This furnace differed from the usual type in only one particular. The customary timber buckstays were replaced with structured steel, the uprights being six-inch channels and the belts being eight-inch I-beam with 1-1/8-inch truss rods. These held together at the corners with 1-1/8-inch bolts under the nuts and heads of which were 50-ton car springs. The object of this arrangement was to keep the tension constant. It was apparently satisfactory as no cracks of any magnitude developed in the brick work.

Even though the company exhausted one-quarter of its capital to build the furnace, Burcham no doubt justified the expenditure as necessary to enable Mariscal Mine to become competitive with other regional producers.[14]

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[14]J. A. Udden, "Report on Quicksilver Mine on Section 33, G-3, D. & W. Ry. Co. in Brewster County, Texas, and Adjoining Claims in Section 34 of the Same Block," Exhibit B, 4, in Burcham, "Geological Report on Vivianna Mine"; information on Schuette's college training in, Metallurgy of Quicksilver, 8, fn. 16; detailed description of Scott furnace at Mariscal Mine as cited in Charles G. Maier, "The Present Status of Our Quicksilver Industry," in

The ubiquitous Hüttner-Scott furnace (generally known as the Scott furnace) was the uncontested hallmark of the U.S. mercury mining industry for almost a half-century. First developed in 1875 at New Almaden, California by Robert Scott, a furnace mason, and mechanical engineer H. J. Hüttner, the furnace revolutionized the reduction of mercury from its solid to liquid state, making the process both simple and economical. In the Scott furnace the open ore shaft is replaced by one or more pairs of narrow shafts containing shelves of fire-clay tile set at an angle of 45 degrees and placed alternately against the walls of the shafts to form a zigzag pattern. These form a series of inclined hearths down which the ore travels by gravity. The ore is heated by the hot gases emanating from the fire box below, which pass through the flues formed by the inclined tiles. A single shaft usually contains about 26 tiers of tile, making the vertical dimension of the shaft itself about 30 feet. The length of the furnace is determined by the number of tile used in each tier, usually from two to five; and the width is determined by the number of shafts (the furnace at Mariscal Mine being a four-tile, four-shaft variety).

The walls that separate the fire box and dust chambers from the ore shafts are commonly called the "pigeon walls" and are perforated by ports known as "pigeon holes," which correspond to the flues under the various tiers of tile. The fire box communicates directly with the flues in the lower third of the furnace. Hot gases, after traversing through these flues, rise in and pass through the chamber at the rear of the furnace to the next set of flues until they enter the chamber directly above the firebox. Here the gas stream again takes an upward path, and after traversing the flues in the top third of the furnace, passes through the upper dust chamber to the exit pipes. The gas stream thus follows an S-shaped path and in traversing the ore shaft three times approximates concurrent flow. Each pair of shafts is charged through a narrow throat that extends the length of these shafts. Meanwhile, the roasted ores are extracted from the furnace at the bottom through an opening known as the "draw." The Scott furnace is usually built upon a massive foundation of either masonry or concrete. Finally, the furnace is equipped with a mechanical discharger (i.e ore cart tramway at Mariscal Mine) that delivers the roasted waste into cars in a central tunnel under the furnace. (see Drawings Sheet 9)

Built of ordinary red brick, most Scott furnaces have external bracing in which the buckstays and horizontal members are generally constructed of timber. Because of the potential for an

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Quicksilver Industry in 1929, Technical Publication 64 (New York: The American Institute of Mining and Metallurgical Engineers, 1929), 22-23; Casey, 228-43.

external fire that could virtually devastate the entire superstructure, some Scott furnaces, such as the one at Mariscal Mine, were braced with structural steel. (see Drawings Sheet 10) Peepholes, made from either rectangular or circular metal plates were placed on the outer walls of the furnace to correspond with the pigeonholes on the interior walls. In the event of a "hang-up" workers introduced an iron rod through the peephole to loosen the ore. Typically, a four-shaft, four-tile furnace processed 40 to 50 tons of ore in a 24-hour period. Toward the end of its usefulness to the industry, proponents of the Scott furnace heralded the fading technology as antiquated but nonetheless practical. "It is true that the well-seasoned, saturated Scott furnace functions beautifully," wrote Charles G. Maier in a scientific paper presented in San Francisco in October 1929. "It [Scott furnace] is practically automatic in its operation," he noted, "requiring little attention to keep it in proper working order." "The percentage of recovery is of the highest," Maier concluded.[15]

From all indications, however, the Scott furnace that Burcham and Schuette installed at Mariscal Mine was plagued with flaws from the outset. According to Lloyd Wade, a former employee of Burcham's who was interviewed several years later, the furnace was inefficient and consequently not as productive as the general manager had envisioned. The mine apparently suffered from other inadequacies that seem to have been manifested in the condenser system. Sometime in 1919, when Burcham and Schuette built the Scott furnace, they also constructed a series of three concrete condenser chambers that were connected to the furnace by large ceramic tubes. These condenser units, only one of which appears to have seen regular use, were connected in turn by four smaller ceramic tubes to a large limestone chimney located about 100 yards uphill. Perhaps in hope of reducing the amount of stack loss of refined ore, Burcham erected two large redwood tanks on the east side of the condensers through which all fumes were diverted en route to the chimney.

Despite some detectable inefficiencies, the condenser system at Mariscal Mine functioned in a fashion that was standard to the industry. The heated gases from the furnace ordinarily were reduced in temperature by bringing them into contact with the cooler surfaces of the condenser, in which temperatures were lowered by either air cooling, water,--or as in the case of the Mariscal system--both. (see Drawings Sheet 11) The condensed liquid mercury then was collected in gutter-like drains that run

[15]Duschak and Schuette, The Metallurgy of Quicksilver, 47-51; quote on efficacy of Scott furnace cited in, Maier, "The Present Status of Our Quicksilver Industry," 21-22.

along the lower side and bottom of the condensers from which it could be bottled into the cast iron flasks for shipment. Oftentimes the resultant residue, or mercurial soot, also requires collection and reprocessing to extract all remaining traces of quicksilver. Although the two processes of cooling and collecting are considered separately, in actual operation they are largely simultaneous. [16]

Mariscal Mine expanded its operation in other ways as well. Some one hundred yards downhill from the Scott furnace, directly below the original ore bins and retorts employed in the Ellis operation, the company erected a stone building that served as both a small commissary and the company's main office. Although Burcham paid his laborers in U.S. currency, most of their wages were recaptured through the purchase of household commodities, clothing and groceries from store manager Rocindo Rodríguez. Above the commissary, the company installed a blacksmith shop, where Filberto Marufo, reportedly a deserter from the Mexican Army, attended to virtually all of the mine's mechanical needs. Opposite his shop, a large concrete platform housed the engine and hoist equipment required to operate the headframe from which large trapezoidal-shaped buckets were lowered into the main shaft. Of the twenty to forty men employed at Mariscal Mine all were Mexican nationals except Burcham, mine superintendent W. R. Wyatt, foreman Schuette and an unknown brick-kiln specialist. Although the company paid little, it did erect twenty or more two-room dry masonry stone and adobe structures (see Drawings Sheet 4) to house some of its workers. In contrast to these modest dwellings, Superintendent Wyatt's residence was a six-room, adobe brick and framed house with pitched roof and an unattached garage.

More devastating than its numerous technological difficulties, Mariscal Mine suffered numerous financial setbacks during the course of its operation that coincided with a declining commercial market for processed mercury. During its four years of operation (1919-1923) Burcham found it necessary to refinance the Mariscal Mining Company at least three times. On August 26, 1921, the corporation created a Board of Trustees, which promptly authorized the issuance of 200,000 shares of stock at 10 cents per share to help revive the struggling enterprise. Concurrently, the San Francisco price for mercury plummeted to $47 per flask, forcing the company to borrow an additional $20,000 against its deed of trust, which included all of its

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[16] Casey, Soldiers, Ranchers and Miners, 234-37; Clifford Casey with Lloyd Wade, February 27, 1968, Oral History Collection, Big Bend National Park; J. Harlan Johnson, "A History of Mercury Mining in the Terlingua District of Texas," Part III, Mines Magazine (March 1947), 30.

mining properties. For the remainder of its corporate history, Mariscal Mine borrowed money in hope that the market, which did rise modestly during 1922-23 to $65 per flask, would eventually rebound.

Apparently, Billy Burcham's hope was never realized. In light of all of these problems, the Mariscal Mining Company produced a mere 394 flasks of mercury before it officially closed down in 1923. Most of the activity during this period was devoted to exploration and improvement of the mine's facilities at the expense of actual processing. This probably accounts for the meager output Mariscal Mine achieved during its tenure. Following the mine's shutdown, there was no activity at Mariscal for more than a decade. In 1934 H. R. Gard of Alpine attempted to secure financial backing to reopen the mine but failed. Two years later, A. C. Spalding, one of many investors who had loaned money to Burcham, filed a suit against the defunct company in Brewster County District Court. The judge ruled that Mr. Spalding had a valid claim. He not only awarded Spalding the sum of $19,687.40 but also ruled that all of the properties of the former Mariscal Mining Company be sold at public auction. Not surprisingly, Spalding assumed title to all of the mine's properties for a token bid of $100.00. Notably, the judgement did not carry with it the rights to mineral claims or mineral leases in Section 33, which reverted to their original owner, the Texas and Pacific Railway Company.[17]

Burcham's hope for a resurgence in the commercial market for mercury did not materialize until the advent of the Second World War. As in the first global conflict, the demand as well as the price for mercury went up. In response, Billy Burcham reorganized financially and reopened his mine in 1942 under the new rubric Vivianna Mining Company. Just as he had before, Burcham expanded exploration to create two standard 4 x 5-foot compartments; the main shaft reaching the 438-foot level, and a north shaft extending to about 100 feet. In all, the Vivianna Mine comprised more than 2,000 feet of underground workings at intervals descending to 250 feet below the surface. (see Drawings Sheet 5) Mine owners used a D-13000 Caterpillar engine to hoist the 9-cubic-foot buckets into and out of the shaft.

Burcham's most notable modification to the previous operation was the installation of a 30-ton Gould-type rotary furnace, which replaced the inefficient Scott furnace that had presented

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[17]Casey, <u>Soldiers, Ranchers and Miners</u>, 228-32, 244-49; references to W. R. Wyatt as Mariscal Mine superintendent cited in, Weed, <u>The Mines Handbook</u>, 1922, 1475; production statistics for Mariscal, Ibid., 1926, 1453 Maxwell, "The Mariscal Mine," 276.

problems in 1919. Not surprisingly, the Chisos Mining Company introduced the first rotary furnace to west Texas. Typically, furnace shells, averaging 50-60 feet in length and set at an incline of 1 foot for every 8 feet of pipe extending outward from a firebox, positioned at one end of the kiln over a small pit into which the roasted ore is discharged. (see Drawings Sheet 12) Most furnaces rotated at one-third to two-thirds revolution a minute, processing about 30-50 tons of ore in a 24-hour period. On the whole, rotary kilns were far more productive as well as more efficient than the old Scott furnace. In the latter, for example, the ore is heated very gradually, frequently taking 24 hours or more to complete the process. With the rotary kiln, such as the model installed at the Vivianna Mine, reduction time never exceeded more than an hour. Because of the short roasting period, however, the grade of ore fed to the rotary furnace had to be fairly standard. A second obvious advantage of the rotary furnace was its mobility. Unlike the Scott furnace, the rotary could be easily disassembled and moved whenever necessary. Impressed with this latest technology, it may have been Burcham who ordered the Scott furnace partly dismantled in an effort to reprocess the mercury-soaked brick.[18]

It appears that Billy Burcham harbored great expectations for the Vivianna Mine because the company built ten additional three-room concrete houses for the mine workers, which apparently were never occupied. (see Drawings Sheet 4) In the end, even modern technology and Burcham's incurable optimism could not make the Vivianna Mine a commercial success. In fact, during its two years of production, Burcham's latest venture accounted for a sum total of 97 flasks of mercury before once again succumbing to financial distress. The 83rd Judicial District Court in Alpine declared the Vivianna Mining Company insolvent in late 1944. Accordingly, the judge declared the debt-ridden company dissolved and ordered it into receivership. Not one to surrender easily, General Manager Billy Burcham made one last futile attempt to salvage the operation through a proposal he submitted on December 21, 1946. The plan, it seems, was never executed.

What remained of the Vivianna Mining Company, a disparate array of structures and mining equipment that had accumulated since the Ellis Mine operated in 1916, was sold to the highest bidder for

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[18]Burcham, "Geological Report on the Vivianna Mine," 1-3; Robert G. Yates and George A. Thompson, The Viviana[sic] Quicksilver Mine, Mariscal Mining District, Brewster County, Texas, Press Release #27684, October 12, 1943 (U.S. Department of the Interior, Geological Survey, Washington), 1-3; for detailed discussion of rotary furnace see, Duschak and Schuette, Metallurgy of Quicksilver, 94-97; on advantages of the rotary kiln see, Maier, "Present Status of Quicksilver Industry," 21-25.

$7,250. In 1948 Robert N. Pulliam, owner of Bob's Mining Company, disassembled most of the functional equipment, transporting it to the Terlingua District, where mines such as the Maggie May remained operational. Portions of the Gould rotary furnace were reported to have been sent to Arizona sometime in the mid-1950s, where it was put to use in the reduction of uranium. As for Billy Burcham, he remained in the Big Bend region where it was reported he lent his expertise to mining operations across the Rio Grande at the Puerto Rico Mining Company. On May 31, 1972, at the age of 87, the indefatigable William David Burcham died in Brewster Memorial Hospital, Alpine, Texas. With his demise, the forty-year history of mercury mining at Mariscal was brought to closure.[19]

SIGNIFICANCE

For all intents and purposes, the mercury industry in Texas ceased to exist with America's entry into the Cold War Era as strategic interests shifted away from mercury fulminate to fissionable materials like uranium. While some small scale exploration and sporadic production of mercury continued at the Study Butte Mine (Diamond Shamrock Corporation) into the mid-1960s, domestic demand for quicksilver was limited. In recent years, the development of mercury substitutes coupled with a growing awareness of the environmental effects of the metal, accelerated a downward trend in its commercial value. Moreover, United States producers can no longer effectively compete with their European competitors because of their labor cost advantage. During the past two decades, mercury imported from Canada, Spain, Algeria, Yugoslavia and--ironically--Mexico have supplied most of America's domestic needs.[20]

Today, literally only a shell of the mining operation stands in evidence of nearly a half-century of social and economic activity on Mariscal Mountain. On the westernmost end of the site are the remains of the mining community that once housed an estimated 40-50 Mexican nationals in addition to the non-Hispanic mine superintendent and foreman. Scattered across the plain are numerous unroofed remains of rudimentary shelters as well as more traditional housing in various stages of deterioration. As one progresses up the hill toward the mineworks, the hollow remains of the Ellis retort operation are evident. Fragments of ceramic tile that once formed the condenser system are dispersed all

[19] Burcham, "Geological Report on the Vivianna Mine," 4-8; Casey, Soldiers, Ranchers and Miners, 242-44; Alpine Avalanche, June 8, 1972.

[20] Sharpe, Mercury Mining Industry, 27.

around, but the stone-lined casings of the south retort system remain intact. Those on the north side, however, while discernible are partially covered by tailings produced during subsequent operations.

Immediately overlooking the Ellis mineworks are the structures that best represent Mariscal Mine at the apex of its activity. Most striking is the nearly collapsed Scott furnace partially inset into the side of the mountain, unmistakable because of the thousands of mercury-soaked red brick riddled all around the once massive structure. More imposing, however, are the three sentinel-like condensers, whose sun-baked masonry and concrete walls are visible for miles as one approaches the site via Old River Road. These sturdy structures, too, are mostly skeletal representations of their former appearance. Occasional fragments of decayed timbers and twisted metal suggest the labyrinth of wooden trusses and steel rails that once formed the main ore delivery system from the mine above. Near the pinnacle of the mountain stands the abandoned wreckage of the Vivianna Mine and the now metal-grated shaft from which marketable ore was once removed. At this level, one encounters the few existing indications of the mechanical equipment that became the pulse the mining operation. Most impressive is the rust-covered fire box that once fueled the rotary kiln. Clearly detectable are the metal anchor bolts upon which the main hoist was fixed in order to raise and lower the now heavily oxidized ore buckets, one which lies nearby dilapidated due to years of disuse.

For nearly a century mercury production reigned supreme in west Texas. Today, overshadowed by the awesome oil and gas productivity that has become the economic hallmark of the Permian Basin, the contributions of a once thriving quicksilver industry have all but faded. More telling, perhaps, is the gradual disappearance of its technology, which enabled the industry to sustain itself. For this reason, Mariscal Mine, despite obvious signs of decay and abandonment, assumes increasing importance in the social and economic history of the Big Bend region with the passage of each succeeding year. Embraced within the protective boundaries of Big Bend National Park, Mariscal Mine, perhaps more than any other mining complex to survey the astringent environs of the Trans-Pecos region, best illustrates the Texas mercury mining industry from its boisterous beginnings to its silent demise.

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